Remarks

Amendments to the Claims

Claims 1-13 are pending. Claims 5, 8 and 11 were allowed. Claims 1-4, 6-7, 9, 10, and 12-13 were rejected. Claims 1, and 12-13 have been amended to delete the objected to terms "slowly" and "uniform" recited therein. Claims 1, 12 and 13 have been further amended in response to the 102(e) and 103(a) rejections. Support is found at least in the original claims and at p. 4, line 23 to p. 5, line 6; and p. 5, line 13 to p. 6, line 14.

The applicants appreciate the allowance of claims 5, 8 and 11.

Rejection Under 35 U.S.C. 112, second paragraph

Claims 1, and 12-13 were rejected under 35 U.S.C. § 112, second paragraph, as allegedly indefinite for reciting "slowly" and "uniform." The claims have been amended to delete the objected to terms "slowly" and "uniform" recited therein.

Rejection Under 35 U.S.C. § 102

Claims 1, 3, 4, 6, 7, 10, and 12-13 were rejected under 35 U.S.C. § 102(e) as anticipated by U.S. Patent No. 6,248,469 to Formato et al. ("Formato"). Applicants respectfully traverse this rejection to the extent that it is applied to the claims as amended.

Formato

Formato describes a solid polymer electrolyte membranes (SPEMs) which include a porous polymer substrate interpenetrated with an ion-conducting material (col. 5, lines 62-64; col. 9, line 55 to col. 10, line 43). The polymer substrate is a porous polymer having a pore size in the range of 10 Å to 2000 Å (col. 6, lines 25-50; col. 10, lines 6-8). The ion-conducting

material is a sulfonated, phosphonated or carboxylated aromatic polymer or carboxylic, phosphonic or sulfonic acid substituted non-aromatic polymer such as perfluorinated vinyl ethers (col. 7, lines 10-28; col. 14, lines 9-41).

As such, in the SPEMs described in Formato, the ion-conducting material is a filling material to fill in the pores of the substrate polymer film. The SPEMs do not contain ion-conducting material in the form of a film. Therefore, Formato is relevant only if the ion-conducting material is considered as an oxyacid.

The SPEMs described in Formato are prepared by a two step process. First, a porous substrate polymer film is formed. The porous film is then placed in a solution of the ion-conducting material to allow the pores in the substrate film to be filled with the ion-conducting material. The film filled with the ion-conducting material is then taken out of the solution and allowed to dry (Example 9). Alternatively, the SPEMs can be prepared by casting a common solution of the substrate polymer and the ion-conducting material (col. 16, lines 38-57).

The claimed invention

The claims as amended are drawn to a proton conducting polymeric membrane, the method of making the membrane, and a fuel cell formed of the membrane. The method of making the polymeric membrane includes the following steps: (1) dissolving a polymer in an organic solvent to form a polymer solution; (b) adding an oxyacid to the polymer solution; (c) casting the oxyacid-containing polymer solution onto a casting surface; and (d) removing the organic solvent so as to form a proton conducting polymeric membrane.

The oxyacid defined in the claims as amended is a molecular acid. As defined at p. 4, line 23 to p. 5, line 6; and p. 5, line 13 to p. 6, line 14 of the specification, exemplary useful molecular acids include boric acid, carbonic acid, cyanic acid, isocyanic acid, silicic acid, nitric acid, nitrous acid, phosphoric acid, phosphorous acid, hypophosphorous acid, arsenic acid, arsenious acid, antimonic acid, sulfuric acid, sulfurous acid, selenic acid, selenious acid, telluric acid, chromic acid, dichromic acid, perchloric acid, chloric acid, chlorous acid, hypochlorous acid, bromic acid, bromous acid, hypobromous acid, periodic acid, iodic acid, hypoiodous acid, permanganic acid, manganic acid, pertechnetic acid, technetic acid, perrhehhic acid, rehnnic acids, and condensation products thereof. The oxyacid may optionally bear a substituent such as alkyl, fluoroalkyl, alkoxy, flouroalkoxy, alkylamino, fluoroalkylamino, aryl, aryloxy, or arylamino groups. The aryl group may optionally bear a substituent such as a halo, alkyl, fluoroalkyl, alkoxy, fluoroalkoxy, alkylamino, or fluoroalkylamino group.

Therefore, to the extent that Formato is relevant, it requires an ion conducting material formed of a polymer derivatized with sulfonyl, phosphoryl, or carboxyl groups as an oxyacid. The oxyacid defined in the claims is a molecular acid rather than polymeric acid. As such, Formato does not anticipate claims 1, 3, 4, 6, 7, 10, and 12-13, as amended, under 35 U.S.C. § 102(e).

Rejection Under 35 U.S.C. § 103

Claims 2 and 9 were rejected under 35 U.S.C. § 103 as obvious over Formato. The applicants respectfully disagree if the rejection is applied to the claims as amended.

First, as discussed above, to the extent that Formato is relevant, it requires a polymer derivatized with sulfonyl, phosphoryl, or carboxylated groups as oxyacid. In contrast, the claims as amended require a molecular oxyacid rather than a polymeric oxyacid. Therefore, Formato failed to disclose each and every element of the claimed method and film. Second, Formato does not provide motivation for one of ordinary skill in the art to incorporate a molecular oxyacid defined in claims 2 and 9 of the present application into the SPEMs defined therein. In contrast, Formato teaches rinse out, wash away the molecular acidic residue when an acid such as sulfuric acid is used as solvent in the process of making the film forming polymer. Thirdly, even if Formato provided motivation for one to make and use the method and membrane defined in the claims, Formato still fails to lead one of ordinary skill in the art to have a reasonable expectation of success of the method of defined by claims 2 and 9. As discussed above, a molecular oxyacid, if used in the process defined in Formato, would be washed away or neutralized. As such, Formato does not make claims 2 and 9 *prima facie* obvious.

Moreover, Formato teaches away from claims 2 and 9. Contrary to the claimed method, Formato teaches washing away the molecular acidic residues from the SPEMs described therein. Therefore, Formato teaches away from claims 2 and 9 and other claims, as amended. As such, the amended claims 2 and 9 and any other claims, are not obvious under 35 U.S.C. § 103 over Formato.

Marked Up Version of Amended Claims

Pursuant to 37 C.F.R. § 1.121(c)(1)(ii)

1. (twice amended) A method for making a proton conducting polymeric membrane, comprising

dissolving a polymer in an organic solvent to form a polymer solution;

adding an oxyacid to the polymer solution;

casting the oxyacid-containing polymer solution onto a casting surface; and

removing the organic solvent [slowly] so as to form a [uniform] proton conducting polymeric membrane,

wherein the oxyacid is a molecular acid.

2. The method of claim 1 further comprising adding water to the oxyacid-containing polymer solution in a molar ratio equivalent to the oxyacid.

3. The method of claim 1 further comprising concentrating the oxyacid-containing polymer solution prior to casting the oxyacid-containing polymer solution onto the casting surface.

4. The method of claim 1 wherein the polymer is selected from polyphosphazenes, polyalkenes, polyacrylics, polyvinyl ethers, polyvinylhalides, polystyrenes, polyesters, polyurethanes, and polyamides.

5. A method for making a proton conducting polymeric membrane, comprising

dissolving a polymer in an organic solvent to form a polymer solution;

adding an oxyacid to the polymer solution;

casting the oxyacid-containing polymer solution onto a casting surface; and

removing the organic solvent so as to form a proton conducting polymeric membrane, wherein the polymer is a polyphosphazene.

6. The method of claim 1 wherein the organic solvent is tetrahydrofuran.

7. The method of claim 1 wherein the oxyacid is selected from boric, carbonic, cyanic, isocyanic, silicic, nitric, nitrous, phosphoric, phosphorous, hypophosphorous, arsenic, arsenious, antimonic, sulfuric, sulfurous, selenic, selenious, telluric, chromic, dichromic, perchloric, chloric, chlorous, hypochlorous, bromic, bromous, hypobromous, periodic, iodic, hypoiodous, permanganic, manganic, pertechnetic, technetic, perrhennic, rehnnic acids, and their condensation products.

8. (amended) The method of claim 5 wherein the oxyacid is phosphorous oxychloride.

9. The method of claim 1 wherein the casting surface is formed of or coated with polytetrafluoroethylene.

10. The method of claim 1 wherein the organic solvent is removed by evaporation.

11. A proton conducting polymeric membrane comprising a mixture of a polyphosphazene and an oxyacid.

12. (amended) A proton conducting polymeric membrane made by a method comprising

dissolving a polymer in an organic solvent to form a polymer solution;

adding an oxyacid to the polymer solution;

casting the oxyacid-containing polymer solution onto a casting surface; and

removing the organic solvent [slowly] so as to form a [uniform] proton conducting polymeric membrane,

wherein the oxyacid is a molecular acid.

13. (amended) A fuel cell comprising a proton conducting polymeric membrane made by a method comprising

dissolving a polymer in an organic solvent to form a polymer solution;

adding an oxyacid to the polymer solution;

casting the oxyacid-containing polymer solution onto a casting surface; and

removing the organic solvent [slowly] so as to form a [uniform] proton conducting polymeric membrane,

wherein the oxyacid is a molecular acid.

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AMENDMENT AND RESPONSE TO OFFICE ACTION

Clean Version of Amended Claims
Pursuant to 37 C.F.R. § 1.121(c)(1)(ii)

1. (twice amended) A method for making a proton conducting polymeric membrane, comprising

dissolving a polymer in an organic solvent to form a polymer solution;

adding an oxyacid to the polymer solution;

casting the oxyacid-containing polymer solution onto a casting surface; and

removing the organic solvent so as to form a proton conducting polymeric membrane, wherein the oxyacid is a molecular acid.

2. The method of claim 1 further comprising adding water to the oxyacid-containing polymer solution in a molar ratio equivalent to the oxyacid.

3. The method of claim 1 further comprising concentrating the oxyacid-containing polymer solution prior to casting the oxyacid-containing polymer solution onto the casting surface.

4. The method of claim 1 wherein the polymer is selected from polyphosphazenes, polyalkenes, polyacrylics, polyvinyl ethers, polyvinylhalides, polystyrenes, polyesters, polyurethanes, and polyamides.

5. A method for making a proton conducting polymeric membrane, comprising

dissolving a polymer in an organic solvent to form a polymer solution;

adding an oxyacid to the polymer solution;

casting the oxyacid-containing polymer solution onto a casting surface; and

removing the organic solvent so as to form a proton conducting polymeric membrane, wherein the polymer is a polyphosphazene.

6. The method of claim 1 wherein the organic solvent is tetrahydrofuran.

7. The method of claim 1 wherein the oxyacid is selected from boric, carbonic, cyanic, isocyanic, silicic, nitric, nitrous, phosphoric, phosphorous, hypophosphorous, arsenic, arsenious, antimonic, sulfuric, sulfurous, selenic, selenious, telluric, chromic, dichromic, perchloric, chloric, chlorous, hypochlorous, bromic, bromous, hypobromous, periodic, iodic, hypoiodous, permanganic, manganic, pertechnetic, technetic, perrhennic, rehnnic acids, and their condensation products.

8. (amended) The method of claim 5 wherein the oxyacid is phosphorous oxychloride.

9. The method of claim 1 wherein the casting surface is formed of or coated with polytetrafluoroethylene.

10. The method of claim 1 wherein the organic solvent is removed by evaporation.

11. A proton conducting polymeric membrane comprising a mixture of a polyphosphazene and an oxyacid.

12. (amended) A proton conducting polymeric membrane made by a method comprising

dissolving a polymer in an organic solvent to form a polymer solution;

adding an oxyacid to the polymer solution;

casting the oxyacid-containing polymer solution onto a casting surface; and

removing the organic solvent so as to form a proton conducting polymeric membrane,

wherein the oxyacid is a molecular acid.

13. (amended) A fuel cell comprising a proton conducting polymeric membrane made by a method comprising

dissolving a polymer in an organic solvent to form a polymer solution;

adding an oxyacid to the polymer solution;

casting the oxyacid-containing polymer solution onto a casting surface; and

removing the organic solvent so as to form a proton conducting polymeric membrane,

wherein the oxyacid is a molecular acid.